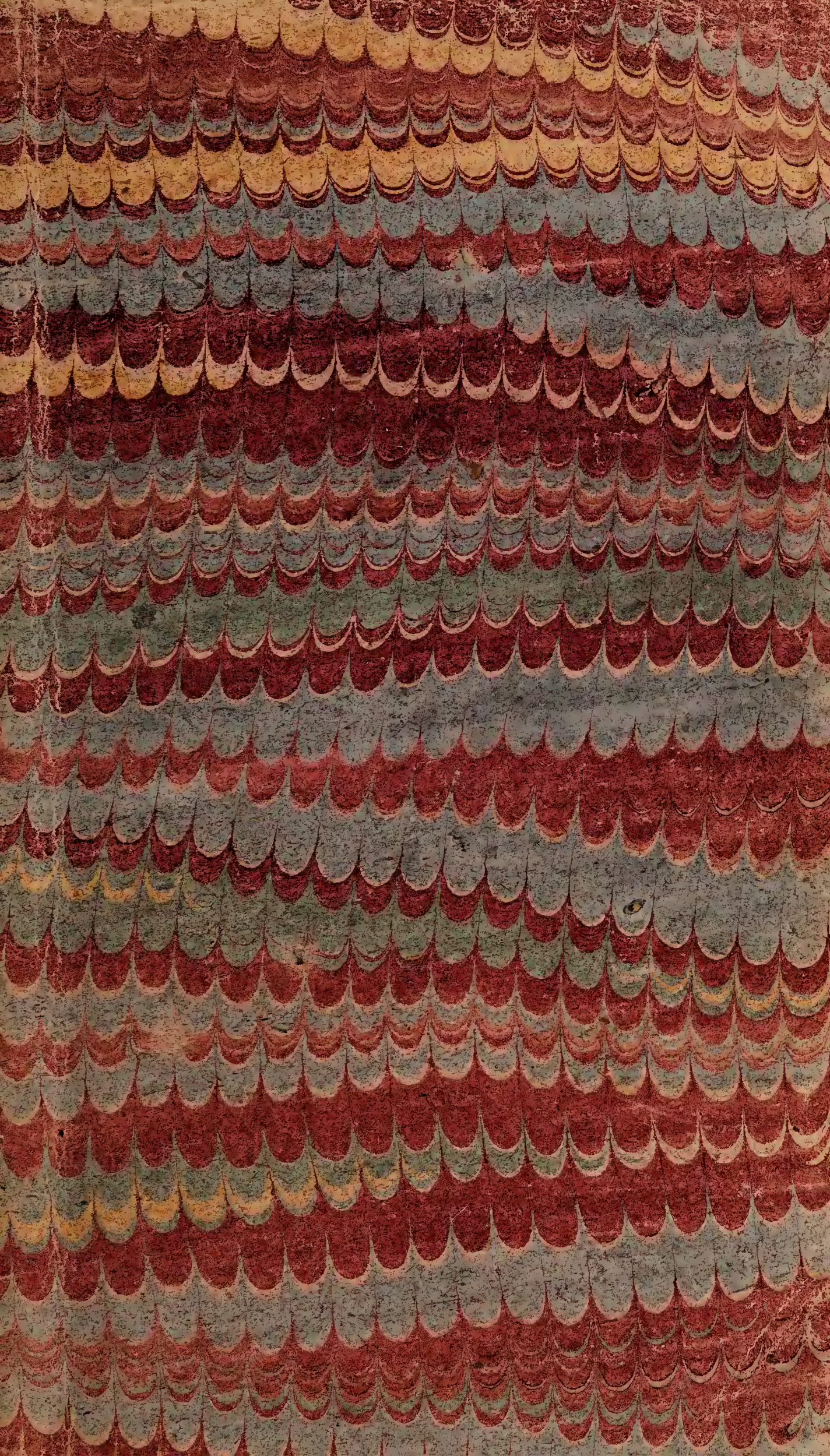

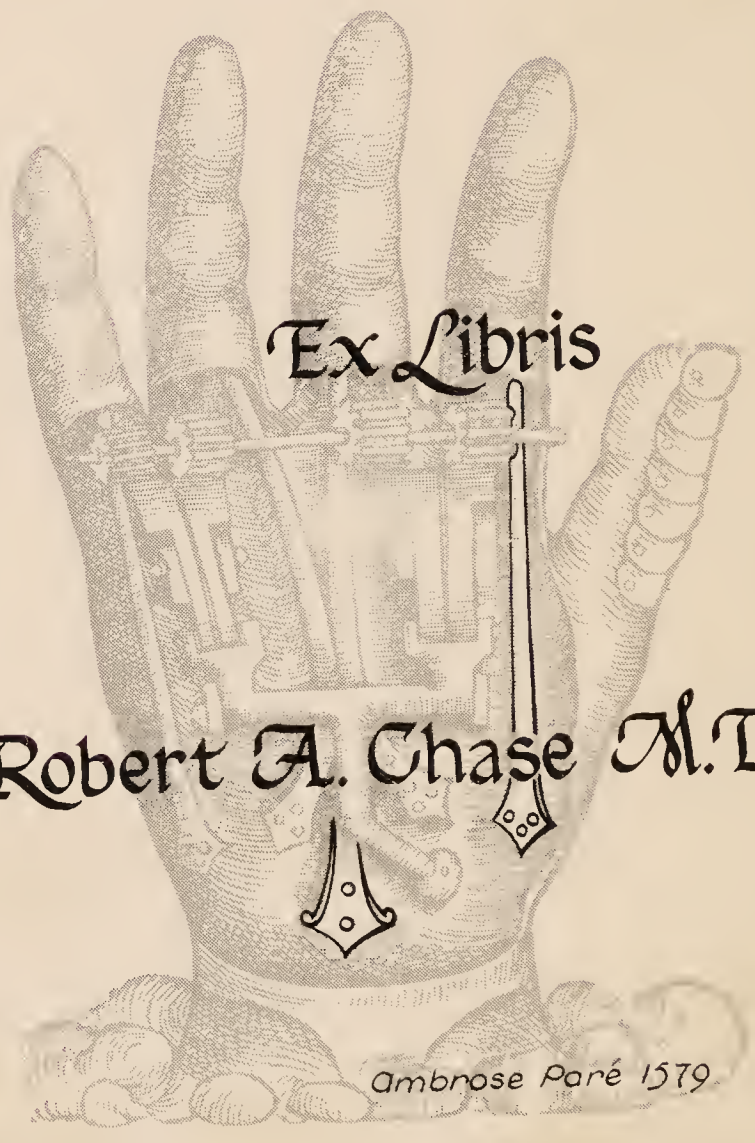

from the Revd J. White

N. 6.

ON THE

REGENERATION

OF

ANIMAL SUBSTANCES.

WARRINGTON,

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A few Copies of this Paper, by Permiſſion of the Society, have been taken off for the Author to preſent to his particular Friends.

On the Regeneration *of* Animal Substances.

By Charles White, *Esq.* F. R. S. *&c. Read December* 18, 1782.

THE great Author of the creation has endowed the animal world with a wonderful power of repairing and recruiting its various compound machines, and not only filling up and making good loſt ſubſtances, but in ſome inſtances, of even totally regenerating parts; but we muſt not from hence accuſe him of partiality, in not doing it in every inſtance; for the further we carry our reſearches into the ſecrets of Nature, the more we ſhall be convinced of the great and unbounded wiſdom of God, and of the extraordinary reſources he has placed in her poſſeſſion;

> - - - - - - - "The firſt Almighty cauſe
> Acts not by partial, but by general laws.
> Pope's Eſſay on Man.

The Deity has drawn the line, has fixed the limits, and has ſaid to Nature, hither ſhalt thou go, and no further.

If this order does not appear to us to be uniformly preſerved, we muſt not conclude that it is not really ſo, but that it is owing to our ſlender capacities, that we are unable to trace his hand through all his ways,

> " See and confeſs, one comfort ſtill muſt riſe,
> " 'Tis this, tho' man's a fool, yet God is wiſe."
>
> Loc. citat.

The antients knew that a freſh broken bone would unite by a callus, that wounds of the fleſh would fill up by what is called incarnation, and would be healed over with ſkin, by what is called cicatrization. But all vain-glorious boaſting man muſt not from hence pretend, that he can make a ſingle fibre grow: this is the act of Nature only. The ableſt ſurgeon living, can do no more than aſſiſt her, remove the preſent obſtacles, and prevent others being thrown in her way.

> " Yes Nature's road muſt ever be preferr'd;
> Reaſon is here no guide, but ſtill a guard."
>
> Loc. citat.

The moderns have carried this matter further.

I did myſelf the honour to lay before the Royal Society, a remarkable caſe of a broken bone, which was inſerted in the Philoſophical Tranſactions, vol. LI. part the ſecond, for the year 1760, in which Nature was diſappointed of her uſual method of throwing out a callus, and after more than ſix months had elapſed, without

without an union; when all obſtacles were removed, by cutting off the ends of the bone, the oſſeous matter ſhot out as freely as if it had been from a recent fracture, and the broken bone was perfectly united. Since the publication of this caſe, a great number of ſimilar ones have occurred, both to myſelf and others, which inconteſtably prove, that though Nature is diſappointed in her work, even for a long time together, yet, when all obſtructions are removed, ſhe is ever ready to exert herſelf.

In the year 1768, I cut off the upper head of the os humeri of Edmund Pollitt, aged fourteen, whoſe caſe is related in the LIX. volume of the Philoſophical Tranſactions. This was much corroded with matter, part of it conſumed, and followed by an exfoliation of a large piece of the whole ſubſtance of the bone; yet the head, neck, and part of the body of it were actually regenerated, and the entire uſe of the joint preſerved.

Mr. William Johnſton, ſurgeon at Dumfries, has given us a caſe in the Edinburgh Medical Eſſays,* where the whole tibia, the principal bone of the leg, being caſt off by exfoliation, was regenerated, and was, in a little time, as uſeful as the old one.

Mr. Le Cat mentions a caſe in the Philoſophical Tranſactions,† of a child of three years old,

* Vol. V. p. 452. † Vol. LVI. p. 270.

from

from whom he extracted the entire tibia, exoſtoſed and carious in its whole extent, between the two articulations; which had remained ſound: this great deficiency of bony ſubſtance was entirely ſupplied again by nature, and the patient regained a new tibia, much firmer than that which he had loſt.

In the ſame place, he relates the caſe of an adult perſon where he took out three inches and ten lines of the bone of the upper arm, which was followed by a regeneration of bony matter. In this caſe the form of the bone, as well as its natural length, was preſerved.*

Both in compound luxations and in caries,† the heads of the principal bones, and conſiderable portions of their bodies have been ſawn off, and regenerated, ſuch as the tibia, fibula, humerus, radius, ulna, thumb, and finger; the bones were little or no ſhorter, and new joints were formed, with ſuch a degree of motion, that the patients found little or no inconvenience, and were able to follow their buſineſs as well as ever.

Dr. Hunter, in his reflections on cutting the ſymphyſis of the pubis,‡ ſays, "as to any property which living ligaments poſſeſs of ſtretching,

* Gooch's Caſes, vol. I. p. 323.

† Phil. Tranſ. vol. LIX. p. 39.

‡ Letter to Dr. Vaughan, p. 86.

under

under violence, permitting diſlocations without laceration, I have long taught, that though a very general opinion, it ſeems not to have been founded in obſervation. Ligaments will not allow of diſlocations in dead bodies without laceration; and elaſticity to any degree either in ligaments or tendons, would ill agree with their uſe in living bodies, which is to keep the parts ſtrongly together; and accordingly, ſince this opinion has rouſed attention and examination, every caſe of a recent diſlocation that I have known examined, has been found complicated with a laceration of the ligaments."

Mr. John Hunter, in his Chirurgical Lectures goes further, and ſays, " that a luxated bone not reduced, by preſſing againſt another bone, digs a cavity for itſelf, which gets cartilaginous edges and cartilage on all its ſurface; nay, a ſynovial gland ſecreting ſynovia, and a new joint is ſet up. In the fracture of a bone, though the parts be thrown at ſome diſtance, a callus is formed, which unites them. It is agreeable to the ſame uniformity of operation, that when a bone is broken, which was originally formed in a nidus of cartilage, the renovated bone alſo forms in cartilage; while a bone, originally formed in membrane, when it is partially deſtroyed, is reproduced in membrane." All ſurgeons muſt have obſerved this, that in old diſlocations which have not been reduced, there is always ſome degree

of

of motion more or leſs in the diſlocated joint, except it has been complicated with a fracture.

In a converſation I lately had with Dr. Monro, he confirmed Dr. Hunter's opinion, with the relation of the two following diſſections. He immerſed a dead child in warm water, till it was perfectly ſoft and flexible; he then diſlocated the ſhoulder. Upon diſſecting the parts, he found the capſular ligament lacerated.

A man in Edinburgh was killed by a fall from a horſe, and his ſhoulder was at the ſame time diſlocated. Upon diſſection in this caſe alſo, he found the capſular ligament lacerated.

Dr. Monro told me, he did not in the leaſt doubt what Mr. John Hunter had advanced on this ſubject; and informed me, that he had a caſe, laſt winter, of a patient who had an exfoliation of half the lower jaw, particularly of the whole condyle on the left ſide; the loſt part was regenerated, he had the entire uſe of the jaw, and the joint was as perfect as on the other ſide, except being a little fuller, and attended with a trifling degree of hardneſs. I had the ſatisfaction of ſeeing the exfoliated bone amongſt his valuable collection, and found the head of the bone perfect, except a little carious on one ſide.

In the ſame collection I ſaw an aſtragalus, (one of the bones of the foot) which had come away entire, and the patient, as Mr. Fyfe informed me, had the perfect uſe of his foot and

ancle.

ancle. I likewiſe ſaw in the ſame place, a thigh bone, which had been broken, the ends had not coaptated, but had overſhot each other three inches, and were perfectly united. Caſes of this ſort I have often ſeen, and have now a thigh bone by me, united in the ſame manner; but in that bone in the poſſeſſion of Dr. Monro, there is this circumſtance, which I had never before obſerved, that the ſides of the bone had not approximated each other, but in one point. The callus had ſhot out in ſuch a manner as to form cancelli, and the void ſpace had all the appearance of having contained a medullary ſubſtance. Dr. Monro told me he had a whole cheſt of regenerated bones in his poſſeſſion. He likewiſe deſcribed to me the following experiment, he had made.

He laid open the abdomen of a pig for ſeveral inches, in ſuch a manner, that the inteſtines protruded; which convinced him, that all the integuments were completely divided. He then reduced the inteſtines, and ſewed up the wound. After it was perfectly united, he killed the pig. He then made inciſions above and below, and on one ſide of the cicatrix; after which, he injected the aorta; and, though there was not a poſſibility of the injection entering but on one ſide of the cicatrix, yet the arteries, on both ſides, were perfectly injected, a convincing proof, that they muſt have regenerated, for it cannot be

ſuppoſed that the mouths of ſo many ſmall veſſels could poſſibly have coaptated, ſo as to have continued the circulation through the cicatrix. I had the ſatisfaction of ſeeing both the preparation and an engraving from it, which, it is hoped, the doctor will favour the public with, together with the ſeveral other valuable experiments.*

Teeth have regenerated in every period of life. Mr. Thornton, a very ingenious medical ſtudent at Edinburgh, informed me, that he had a ſound tooth drawn by miſtake ſome years ago, which as ſoon as he found out he immediately replaced. It grew again, and was as good in every reſpect as any other. But in proceſs of time, this tooth began to decay, and give him pain, which became exquiſite whenever the tooth was touched, even in the ſlighteſt manner. He therefore had it drawn, and one of the fangs was found to be carious. From this it is very evident, that nerves will grow again, after being diſunited.

Mr. Cruikſhanks, in his Letter to Mr. Clare, p. 87, ſays, "Not only the brain, but the nerves alſo, appear to have other properties than we have hitherto apprehended. Some years ago, I

* Since this paper was read before the Society, Dr. Monro has publiſhed his uſeful and ingenious obſervations on the nervous ſyſtem, with the engravings of theſe preparations. Vid. Tab. XLVI. and Tab. XLVII.

demonſtrated,

demonſtrated, by experiments on living animals, that nerves divided unite again; and that when portions had been cut out, they were regenerated: in both inſtances the animals perfectly recovered. Theſe experiments I hope ſoon to be able to lay before the public; meantime I am happy to find, they have been recently confirmed by ſo great authority, as the Abbè Fontanà, to whom I communicated my diſcovery, and ſhewed my preparations of united and regenerated nerves."*

Mr. Gooch has given us a remarkable caſe of the cuticle and nails,† being frequently caſt off and regenerated, particularly in the feet and hands, ſometimes twice in a year. Thoſe of the hands where caſt off whole, and we are furniſhed with an engraving of a pair of theſe cuticular gloves.

There is another ſimilar caſe related by Mr. Latham,‡ but with this difference, that this patient did not caſt her nails.

* Dr. Monro, in the work before mentioned, has given a plate (Vid. Tab. XIV.) to ſhew the regeneration of the ſciatic nerves, which had been divided in living frogs, and diſſected twelve months after. The regenerated parts are of a darker colour than the original nerves, which proves, that there was not a mere coaptation of the divided ends.

† Philoſophical Tranſactions, vol. LIX. p. 281.

‡ Ibid. vol. LX. p. 451.

By performing the operation for the cure of the aneuriſm, ſeveral inches of the trunks of the principal arteries, both of the arm and the thigh, have been deſtroyed; yet in a few days, the circulation through the whole limb, has been carried on, as perfectly, as before the operation. The method, which nature has taken for accompliſhing this buſineſs, may be ſeen by an engraving* from a preparation which I made, and which Dr. Hunter has done me the honour to give a place amongſt his valuable collection.

There is a very extraordinary hiſtory of a glans penis regenerated after amputation, related by Mr. Jamiſon, ſurgeon at Kelſo, and inſerted in the Edinburgh Medical Eſſays.† The young man was married, in that country, about two years after the cure, has had two children, and complains not of want or defect even in ſenſation.

Crabs and lobſters caſt their ſhells, both from their bodies, legs, and claws, and even caſt their ſtomachs, generally every year, which are immediately regenerated. The ſhell is renewed by a fluid, which they eject; and it inveſts their whole body, growing hard and dry, in a ſhort time, and becoming as ſtrong a ſhell, as that which they had before. But, what is more extraordinary, they frequently loſe a leg or a

* See my Caſes in Surgery, p. 140.

† Vol. VI. p. 434.

claw

claw in their combats, which are very frequent and furious: the loſt part will be regenerated in about three weeks, and be almoſt of its natural ſize. Brown, in his hiſtory of Jamaica, informs us, that the claw of the violet crab, in ſeizing its food, catches ſuch an hold, that the animal loſes its limb ſooner than its graſp; the claw continuing its retentive power for above a minute, whilſt the crab is moving off.

In the polypus, not only young ones will grow out like warts from different parts of the body, drop off, live, and grow; but you may cut them into a thouſand pieces, and turn them inſide out, and they will ſtill live, and do well; this is accounted for by its whole body being compoſed of ſtomach and parts of generation. The latter not being peculiar organs, but merely particles of the ſtomach, which are its body, each part of which has the power of producing the like. Its food is converted into chyle, in the ſtomach; abſorbents opening into the part, take up the chyle, and theſe, at ſome diſtance from their mouths, become arteries.

If the *Actinia Urtica Marina*, *Animal flower*, or *Sea-Anemone* be cut through the middle, either tranſverſely or longitudinally, both parts will ſurvive the operation. Nay further, if you tear them from the rock or ſhell, to which they generally adhere, and a ſhred is left behind, it will become a freſh and perfect animal.

The

The earth-worm and ſea-worm will live after being cut in two; but, what is moſt ſurprizing, the ſmall red headed earth-worm, being cut in two, both extremities ſurvive the operation; the head produces a tail, with the anus, the inteſtines, the anular muſcles, and the prickly beards: the tail on the other hand, is ſeen to ſhoot forth the noble organs, and, in leſs than three months, ſends forth a head, heart, together with all the apparatus and inſtruments of generation. Theſe parts, as may be eaſily ſuppoſed, were produced much ſlower than the former; a new head taking nearly three months for its completion; a new tail ſhooting forth in leſs than as many weeks. The lizard, and alſo the viper caſt their ſkin, and ſome ſay their tail, and even their eyes; and the ſea-ſlug is ſaid to caſt its head; all which are regenerated.

The buck caſts its horns every ſpring, which are reproduced in a few months. But if he be caſtrated when young, he will have no horns at all, or ſmall buds only, and thoſe ſoft to the touch, like velvet, and void of firmneſs. Dr. Ruſſel informs us, that he had two old bucks caſtrated at the end of February, and their horns dropped off, the twenty-firſt of March following; ſo that the fall of their horns was anticipated five weeks at leaſt. Theſe horns were renewed, next year, and were longer than the buck's of the ſame age; but the palms, or collateral branches,

branches, were leſs and ſhorter, and neither the velvet of the horns, nor the horns themſelves, were ever caſt afterwards.

I ſhall now beg leave to lay before the Society, two caſes, that have not been publiſhed, in order to prove ſtill further the doctrine I have been endeavouring to eſtabliſh.

Roger Nuttal, of Bury, twenty years of age, was admitted an in-patient of the Mancheſter infirmary, under my care, on the 23d of January, 1775, for a tumor on his back. Upon ſtripping off his ſhirt, to ſhew me the tumor, I was ſtruck with a very ſingular appearance of a ſtump of the right humerus. I aſked him, if he was born with it in that form, or whether his arm had been taken off. He informed me, that Mr. Kay Allen had taken his arm off cloſe to the ſhoulder, when he was but four years old, and that the ſtump was grown again to that length, which ſeemed to be about eight inches longer than he deſcribed it to have been, immediately after the amputation. I enquired both of his mother, and Mr. Allen, as to the truth of his relation, which they both confirmed; and the latter, with this addition, that the arm was taken off, as near the ſhoulder, as the application of the tournequet would permit. The bone had every degree of firmneſs, and ſolidity, and the ſtump was warm to the extreme point, and he informed me, was perfectly ſenſible when touched.

touched. Along with this, you will receive a drawing of the young man, and the appearance which the ſtump made, executed by your ingenious Secretary Mr. Bew, at the time the patient was at the Infirmary.

Some years ago, I delivered a lady of rank of a fine boy, who had two thumbs upon one hand, or rather, a thumb double from the firſt joint, the outer one rather leſs than the other, each part having a perfect nail. When he was about three years old, I was deſired to take off the leſſer one, which I did; but to my great aſtoniſhment it grew again, and along with it, the nail. The family afterwards went to reſide in London, where his father ſhewed it to that excellent operator, William Bromfield, Eſq. ſurgeon to the Queen's houſehold, who ſaid, he ſuppoſed that Mr. White, being afraid of damaging the joint, had not taken it wholly out, but he would diſſect it out entirely, and then it would not return. He accordingly executed the plan, he had deſcribed, with great dexterity, and turned the ball fairly out of the ſocket; notwithſtanding this, it grew again, a freſh nail was formed, and the thumb remains in this ſtate.

The concluſions I would draw from theſe facts, are, that, in the human ſpecies, not only fleſh, ſkin, and bones, may be regenerated, but membranes, ligaments, cartilages, glands, blood veſſels, and even nerves; and this for the wiſeſt purpoſes,

purpoſes, that every part may be repaired in its own kind, and in ſome manner reſtored by the coagulable lymph, which is poured out, and becomes vaſcular, and forms organized parts.

By this wiſe proviſion of nature, the many accidents to which we are continually expoſed, are often more compleatly repaired, than art could be able to accompliſh.

In ſome animals, we ſee this regenerating and living principle, carried ſtill to a much greater length, where not only whole limbs, but even the more noble organs are reproduced.

The ſtudy of nature is not only engaging and pleaſant to a high degree, but it inſpires us with ſuch a reſpect and admiration of the Almighty Being, that it is impoſſible either for a Naturaliſt or an Anatomiſt to be an Atheiſt.

They have conſtantly before their eyes ſo many wonderful living machines, differently wrought, yet ſo compleatly faſhioned, and all tending to one great point, the preſervation of themſelves and their ſpecies; in which, there are ſo many orders of veſſels, one depending upon another, yet compleat in themſelves; capable of repairing injuries they may ſuſtain, and even of reſtoring loſt ſubſtances; that men, who daily ſee ſuch objects, muſt be convinced, that theſe admirable fabrics cannot have proceeded from chance, but muſt have been the work of an Omnipotent Creator, who has

formed them with the moſt perfect wiſdom, and attention to their ſeveral intereſts and ſituations;

> " And ſpite of pride, in erring reaſon's ſpite,
> One truth is clear, Whatever is, is right."
>
> Pope's Eſſay on Man.

P. S. Mr. Parke, of Liverpool, in a Pamphlet he has lately publiſhed, intitled, " an Account of a new Method of treating Diſeaſes of the Joints of the Knee and Elbow," has given us a caſe, which fell under the care of Mr. Wainman, of Skipton in Craven; and, as it is perhaps the fulleſt confirmation, that can poſſibly happen, of the regeneration, of not only the head of a bone, but of the capſular ligament, and ſynovial glands, and even every appendage of a joint, it may, perhaps, be thought to be a proper ſupplement to this paper. I ſhall therefore give the caſe in Mr. Wainman's own words. He deſcribes it, as " a violent luxation of the cubitus, occaſioned by a fall from a horſe in full ſpeed, which forced the os humeri, through the common integuments, a conſiderable length into the ground, and the bone was quite denudated." He adds, " There was not a poſſibility of reducing it, and I thought it moſt eligible to take off the limb, which the family objected to. I called in Dr. Taylor, who was of my opinion; but it would not be complied with. We then judged it beſt

to

to ſaw off the os humeri, which I did, about an inch above the ſinus that receives the olecranon. I then placed the arm, in ſuch a poſition, as I thought would be moſt advantageous, prognoſticating, that an anchyloſis would enſue, in which I was miſtaken; the perſon is now living, and can perform all the motions of the joint, which is as flexible, as if nothing had ever been amiſs."

THE END.